AUTOMATIC TRACKING OBJECT USING SIMPLE ROBOTIC ARM

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Report submitted in partial fulfilment of the requirements
for the award of the degree of
Bachelor of Electric (Electronic) Engineering

Faculty of Electric (Electronic) Engineering
UNIVERSITI MALAYSIA PAHANG

OCTOBER 2010

Bachelor Final Year Project Report

Report submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Electric (Electronic).

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Electric (Electronic) Engineering.

Signature
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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ACKNOWLEDGEMENT

To Dr. Kamarul Hawari Bin Ghazali, for being the best supervisor one could ever had, for making me strive for the best, for asking only the best I could be. Thank you.

To Mr Alias Bin Jamal and Mrs Zaiton Binti Yusof, for being the only set of parents I could ever wish for, for giving me love, care, understanding, money and others, thank you for everything. And for my sisters and brother, who inspire me to strive and fight to be on top, thank you.

To Mr Mohammad Khyru Bin Aris, for believing me and for being patient with me, for giving me courage, trust, love and care that no one else could ever do as perfectly as you. Thank you.

For my best friend, Vrinda Nair, thank you, for believing that I could be the greatest engineer in the world.

For my lecturers and friends, for the endless support and help, whether directly or indirectly, thank you.

A million thank you could not even cover the one I really want to thank, but the most important is I would like to thank You, Allah for being with me all the times, listening to my whines and sighs. Thank You, Allah, for giving me the sets of person that I would like to thank today. Thank You, for all the blesses You have given me.

ABSTRACT

This project is about improvement on the available technology on Closed Circuit Television Camera (CCTV). Nowadays, numerous shops and premises are equipped with CCTV. But, the CCTVs are only mounted on walls and could not detect movement that came out of its angle of surveillance. Therefore, if the CCTV camera is made movable and not static, then it could solve the problem on blind spot by making it movable according to the movement, even outside its angle of surveillance. The main objective of this project is to study the possibility to make the CCTV detectable and recognize any movements from outside its area of surveillance and to study the implementation of the CCTV on a simple robotic arm. The methods that will be used in this project are by using both software and hardware. On software, the image processing on MATLAB as well as Advantech Data Acquisition Card (DAQ) software will be used while on the hardware part, a simple robotic arm will be used and Advantech Data Acquisition Card (DAQ) is also useful for interfacing the software to the hardware. The tools that will be used is a PC, Advantech Data Acquisition Card (DAQ), a simple robotic arm and also a webcam which will represent as a CCTV in this study. The result of this project is that by using image processing on MATLAB could detect and recognize movements that are suspicious. The conclusion of this project is that this detection system could hundred percent detect and track suspicious movements in a control environment.

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ABSTRAK

Projek ini mengenai pengubahsuaian teknologi kamera litar tertutup (CCTV) yang sedia ada. Kebelakangan ini, kebanyakkan kedai dan premis perniagaan telah dilengkapi dengan kamera litar tertutup ini. Namun begitu, disebabkan keadaan fizikalnya yang statik, kamera CCTV ini tidak dapat mengesan pergerakan yang berada di luar sudut pengawasannya. Oleh itu, jika kamera CCTV tersebut boleh dikawal gerakannya, masalah ini dapat di atasi kerana kamera tersebut boleh mengesan gerakan, walaupun di luar sudut pengawasannya. Objektif projek ini adalah untuk mengetahui kebolehan kamera CCTV untuk mengesan dan mengenali gerakan yang luar biasa dari luar sudut pengawasannya dan juga untuk menyambung kamera CCTV tersebut bersama sesuatu tangan robot. Kaedah yang digunapakai dalam projek ini ialah dengan menggunakan perisian komputer dan alatan luaran. Perisian computer yang digunakan ialah "image processing MATLAB" dan "Advantech Data Acquisition Card (DAQ)" manakala alatan yang digunakan ialah sebuah tangan robot dan "Advantech Data Acquisition Card (DAQ)" untuk menghubungkan perisian dan alatan. Alatan lain yang digunakan ialah kamera web sebagai wakil kamera CCTV dan komputer. Hasil daripada projek ini ialah perisian "Image Processing" dalam perisian MATLAB dapat mengesan dan mengenalpasti sebarang pergerakan asing. Kesimpulannya, sistem ini berjaya seratus peratus dalam mengesan dan mengenalpasti sebarang pergerakan asing.

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LIST OF ABBREVIATIONS

FKEE	Fakulti Kejuruteraan Elektrik Elektronik
FYP	Final year project
MATLAB	Math Works Software
DAQ	Data Acquisition Card
PC	Personal Computer
CCTV	Closed Circuit Television
BSA	Background Subtraction Algorithm

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

According to www.NationMaster.com [1], the total crime in Malaysia alone is 167,173. This also position Malaysia as the 32th country with highest crime recorded. Bearing this in mind, merchants, home securities and such are going extra miles to curb crimes in their premises. One of the methods used is by installing Closed Circuit Television or CCTV. Basically, a traditional CCTV is a small camera that is connected to a computer or a screen and uses video cameras to transmit a signal to a specific place [2]. The camera or the computer captures the video; the data is written on the tape and at the same time, shows it on screen. An officer is also needed to monitor the premises based on the screens. The data is used as after forensic tools as the computer does nothing but captures and shows the image. But as more researches have been done, the CCTV is being upgraded with more function and new technologies such as Internet technologies, database technologies, image processing technologies and telecommunication technologies.

However, there are still limitations that need to overcome. Of course, the main objective of installing CCTV is to monitor all location, but it is limited to certain areas only, leaving blind spots and chances behind. Moreover, this could lead to sabotage as unwanted person could disable or dismounted the CCTV from behind. To prevent this, the CCTV is mounted on a simple robotic arm, thus allowing it to be movable so that the officer could look at it from any angle without the need to do rounding every certain period of time.

Nevertheless, to unburden the officer more, the CCTV is equipped with image processing technologies that detect changes in the scene. There are several techniques such as feature-based object detection, template-based object detection and background subtraction or inter-frame difference-based detection. Background subtraction is the most popular method and will be used in this study. Stationary background differencing and silhouette is used to detect object of interest, such as people in this study. The images are extracted from consecutive frames a few seconds apart. After the images were detected by the computer, the camera will then be moved according to the movements and focus on the movements.

The aim of this thesis is to implement a system in MATLAB that is able to detect changes in the scene, as well as recognize the movements made by such changes. The system is built based on image processing using arithmetic and so on. The system will be tested by interfacing the system with an automatic robotic arm, which will move according to the movements or changes.

The goal is to have the system detect and recognize movements and for the robotic arm to move according to the movements. The work in this thesis therefore is an initial step and may not be implemented in real time.

The hardware used is a standard computer, regular webcam, and data acquisition card (DAQ) for interfacing, a simple robotic arm and a DC geared motor.

1.2 PROBLEM STATEMENT

Due to an increasing crime rates, an interest towards extra security has arisen. More and more has installed CCTV on their premises due to affordability. However, traditional CCTV still need an officer to screens the video. The officer still has to do usual rounding every certain period of time as the area of surveillance is limited. The officer, being human could miss a few changes in background, or

being misled by the data itself. The data is recorded in tape and being used after an event has occurred thus losing its primary benefit as active, real time medium.

Therefore, there is a need to develop a system that could detect and track such suspicious movements and interfacing it with a simple robotic arm that could be moveable according to the suspicious movements itself.

1.3 OBJECTIVES

The main objectives of this study are:

I. To develop a CCTV with a system for detecting and recognizing suspicious movements on its surveillance area.

II. To develop a simple robotic arm.

1.4 SCOPES OF STUDY

The study was carried out using Closed Circuit Television as the medium to capture images, shows it on screen and stores it in tape. The image will then be processed using image processing in MATLAB using background differencing or background subtraction. The image processing technology will be able to detect movement of people or suspicious movements and will be moving according to the movement itself. To do so, the CCTV is mounted on simple robotic arm to make it movable. The study also consists of designing software to recognize movements and fabricating the model of simple robotic arm with the CCTV mounted on it.

1.5 PROCESS FLOW CHART

Figure 1.1 shows the separation of information or processes in a step-by-step flow and easy to understand diagrams showing how steps in a process fit together. This makes useful tools for communicating how processes work and for clearly due time limitation on how a particular job is done in FYP 1 and FYP 2

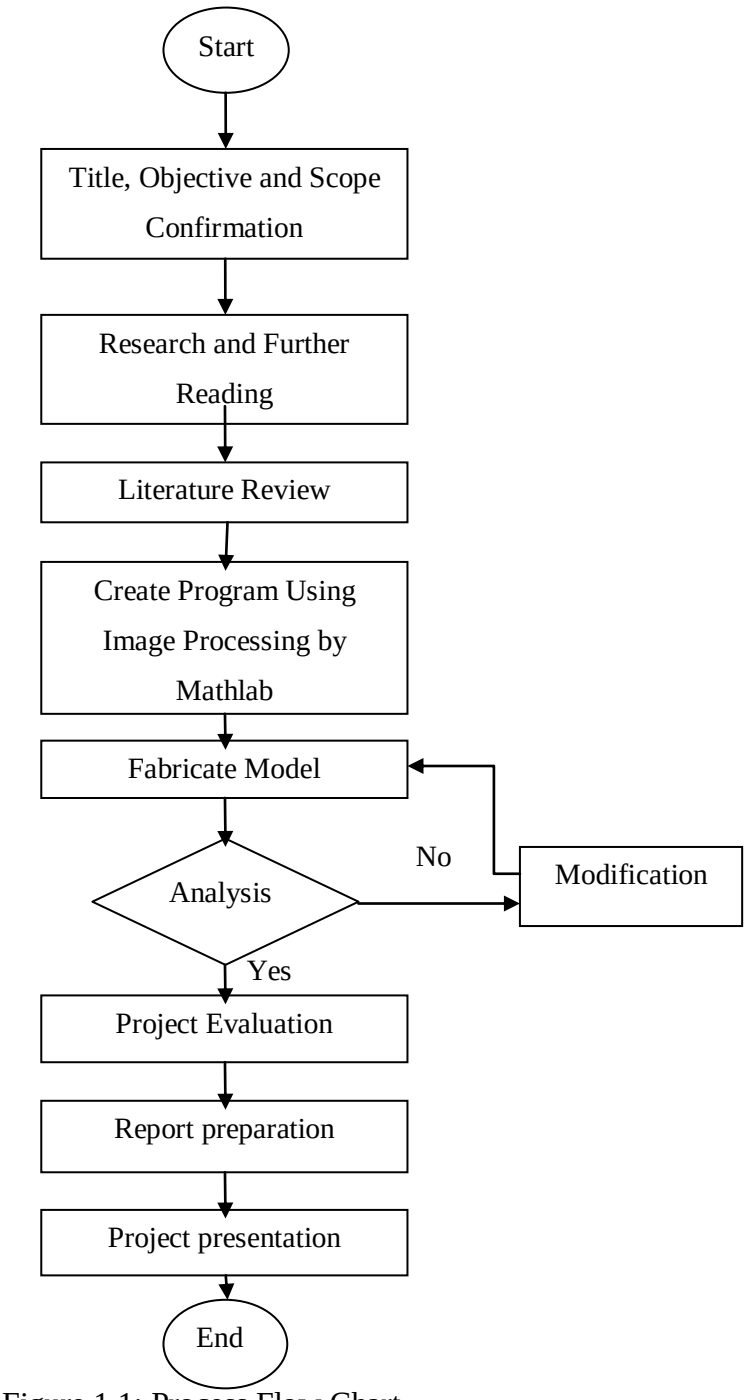

Figure 1.1: Process Flow Chart

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Over the past few years, the crime rates have increase dramatically. In order to curb these crimes, many premises have been equipped with CCTV for extra security. The main aim is to surveillance the whole location. These lead to the needs of an officer or more to survey the premises every certain period or so. More technologies have been added to CCTV's main function so that the improved CCTV could detect movements and so on. However as the CCTV is immobile, there are only certain angle of surveillance could be done. Therefore, the CCTV is mounted on a simple robotic arm to allow it to move accordingly.

2.2 AUTOMATIC TRACKING OBJECT USING SIMPLE ROBOTIC ARM

2.2.1 Automatic tracking object using simple robotic overview

Tracking desired object such as people have been done intensively over past year. Especially after the September 11 attack, many researcher have done studies upon automatic tracking suspicious movements in common premises such as airports, train stations, shop lots and so on. [3] People detection techniques could be

taken into account to restrict the area of interest for an high-level recognition module (Schneiderman and Kanade, 2000 and Gross et al., 2002) or to identify dangerous behaviours (Collins et al., 2001). [4] For example, it can used to detect movements in restricted areas, follow the suspicious movements until safety measures have been taken. Automated video surveillance systems monitor CCTV systems and detect anomalous or suspicious behavior [5-9] with a view to alerting human operators who can take appropriate actions.

To track object, video surveillance must be used. To do so, CCTV is being used in this study. The CCTV system is basically involving a computer and a camera. The camera captures the image in the surveillance area, and the computer shows it on screen. CCTV is mainly managed from a control room where an officer or more can view the area of surveillance. It is vital for these officers to maintain awareness of the activities in these areas. However human have their limitation on maintaining focus more than fifteen minutes. Or in another case, it is too late to act when the damage has been done.

In 1942, the first CCTV installed was by Siemens AG at Test Stand VII in Peenemünde, Germany. This is done as to observe the launch of V-2 rocket. CCTV system recording was used so that the scientists could record the flight of rocket, in order to find if there is any malfunction and defect safely. In September 1968, Oleans, New York has been the first city in United States to install the CCTV in order to fight crime. And in 1960's also, the UK started installing more and more CCTV system in public places to monitor crowds during rallies and appearances of public figures. Furthermore, in UK alone, there is more CCTV alone than the people. Then, the installation of cameras became more popular, both in public spaces and retail stores, as the technology developed. Today, everywhere around the world, especially in Britain, CCTV system is used to monitor roads, premises, and banks, shopping lots, personal use, city centre, stations and airports. In 1996, government spending on CCTV technology accounted for three quarters of the crime prevention budget in the UK. [2]

In addition, UK also installed the CCTV in taxis to prevent violence towards driver, police patrol cars and even most of the car has its own CCTV. As the technology evolved, the CCTV also evolved from only monitoring the place towards many other applications. The CCTV is being updated with other technologies such telecommunication technology, as Internet technologies, database technologies, and image processing technologies. Such technologies bring out certain application to the CCTV. For example, image processing technologies could detect and track people or object movements. There is also a “talking CCTV” which allows the operator to communicate directly towards the offender. [2]

Personal use of CCTV technology has become more widespread as the technology has become much easier to acquire. Many utilize CCTV systems in their own homes to catch cheating spouses, or to monitor the care of their children in "Nannycams". Many crimes have been solved thanks to CCTV usage. Some cases of abused children were also found by CCTV.

However, there is still certain limitation of this wonder device. One of it is that the CCTV could not detect movement outside its angle of surveillance. Although mounting CCTV is cheap, the cost for the officer or officers to monitor it and monitor the place certain period of time is expensive. If only the camera could move according to the officer need, then the officer could do rounding less and if the CCTV could detect the movements outside its angle of surveillance, this will unburden the officer more. Plus, if it is compatible enough and could make it detect movements and alert the security or police, it is much better as it could eliminate the usage of officer, and be less expensive for the owner.

To achieve this goal, we have to do some alteration to the CCTV. To make it mobile, we have to attach it to a simple robotic arm. And to have it detecting and tracking movements, we have to have certain technologies equipped with is, say in this study, image processing technology.

As for image processing, it is a physical process used to convert an image signal into a physical image. The image signal can be either digital or analog. The actual output itself can be an actual physical image or the characteristics of an image.

Application could be created using image processing such as satellite imagery, wirephoto standards conversion, medical imaging, videophone, character recognition, and photo enhancement. Images could also be processed in real time which essential in this study as the detecting and tracking is done in real time, and as CCTV primary benefit as real time medium.

Generally, there are three steps on image processing. The steps taken are:

I. Import an image with an optical scanner or directly through digital photography.

II. Manipulate or analyze the image in some way. This stage can include image enhancement and data compression, or the image may be analyzed to find patterns that aren't visible by the human eye. For example, meteorologists use image processing to analyze satellite photographs. Some other techniques are enhancing images by intensity by using histogram stretching, histogram equalization, and histogram adjustment. Other than that, enhancing images using arithmetic operations such as addition which increase image brightness, multiplications to increase image sharpness, subtraction and division to detect changes in images could also be done.

III. Last be least, output the result. The result might be the image altered in some way or it might be a report based on analysis of the image. The image output could also be based on what techniques are being used.

These three steps are the basic for image processing. However it could add up according to the application preference. In real time medium, the image is fed from the camera or CCTV and was analyze according to the software. Foreground detection algorithms are normally based on background subtraction algorithms

(BSAs) [10–13], although some approaches combine this method with a temporal difference [14]. These methods are based on extracting motion information by thresholding the differences between the current image and a reference image (background) or the previous image, respectively.

BSAs are widely used because they detect not only moving objects but also stationary objects not belonging to the scene. The reference image is defined by assuming a Gaussian model for each pixel. BSAs are normally improved by means of updating their statistical description so as to deal with changing lighting conditions [9,15–16], normally linked with outdoor environments. Some authors present a different model of background, using pixels' maximum and minimum values and the maximum difference between two consecutive frames [13], a model that can clearly take advantage of the updating process. Pixels of each new frame are then classified as belonging to the background or the foreground using the standard eviation to define a threshold. After the segmentation of the foreground pixels, some processing is needed to clean noisy pixels and define foreground objects. The cleaning process usually involves 3x3 median [16] or region-based [13] filtering, although some authors perform a filtering of both images current and background- before computing the difference [12,15].

The proposed method is simpler. No model is needed for the background, just a single image. For outdoor applications this background image may be updated. Tracking algorithms establish a correspondence between the image structures of two consecutive frames. Typically the tracking process involves the matching of image features for non-rigid objects such as people, or correspondence models, widely used with rigid objects like cars. A description of different approaches can be found in Aggarwal's review, [18].

As the proposed tracking algorithm was developed for tracking people, the analysis of previous work is reduce to this particular field. Many approaches have been proposed for tracking a human body, as can be seen in some reviews [18, 19]. Some are applied in relatively controlled [12, 17, 20] or in variable outdoor [13, 16] environments. The proposed system works with blobs, defined as bounding boxes representing the foreground objects.